LETTERS TO THE EDITOR.

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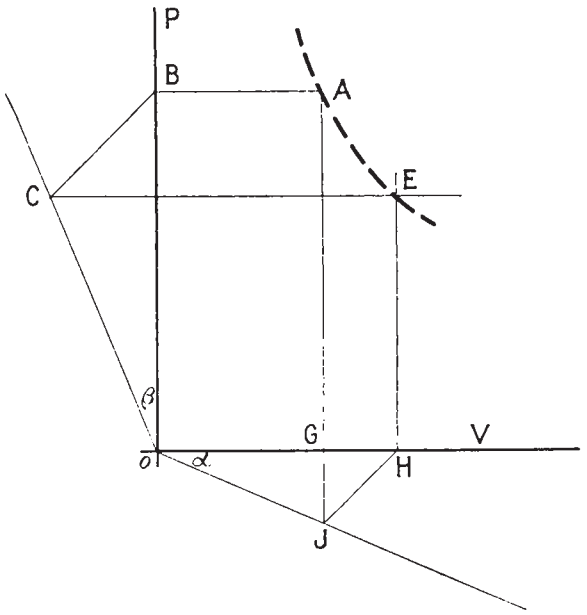
Expansion Curves.

EVERY man who has studied steam or gas or oil engines knows that if there is one construction more important than another it is to draw a curve representing the law

$$pv^n = \text{constant}$$

through any given point. Here is an exceedingly simple, ingenious method of doing this which I have just found in a pamphlet by Mr. E. J. Stoddard, of Detroit. Let A be the given point so that AB represents a given volume,



and AG a given pressure. Set off any convenient angle, VOJ = α say. Compute an angle β such that

$$1 + \tan\beta = (1 + \tan\alpha)^n,$$

and set off BOC = β. Produce AG to J. Now make OBC = JHO = 45°, and project from C and H to find E a point in the curve. The proof is obvious.

It is evident that OC may be drawn to the right of OB, and OJ above OV, to save paper if necessary.

J. PERRY.

Royal College of Science, S.W., September 23.

Botany in Boys Schools.

PROF. W. W. WATTS said in his address to the Geology Section of the British Association, "there is no science in which materials for elementary teaching are so common, so cheap, and everywhere so accessible."

In the light of this statement I sought material for the teaching of another science—botany—in a north London playground last week.

The Angiosperms were represented by thirteen natural orders. With a single representative each of the algæ and fungi, thirty-eight species in all were found growing in or on a soil which is almost entirely ballast!

It seems a pity that botany should be so rarely taught in boys' schools when a single playground yields materials "so cheap and so accessible." H. J. GLOVER.

Stationers' School, Hornsey, N., September 23.

Radium and the Cosmical Time Scale.

CERTAIN letters have appeared in NATURE upon the bearing of the properties of radium upon the cosmical time scale. These letters are based on the assumption that radium, or some equally active body, exists in the sun and contributes materially to the output of solar energy. If this assumption were true, we ought, I think, to be able to detect the rays peculiar to radio-active bodies on the surface of the earth—they should bear some proportion to the great stream of light and heat waves which reaches us.

Now a solution of iodoform in chloroform is very sensitive to the β and γ rays. A purple coloration is produced by the rays from 5mg. of radium bromide even after filtering through 1cm. of lead. On the other hand, I find that direct sunlight (if heating be obviated) has no action when the thinnest opaque screen is interposed even after many days. Some of my solutions are now nearly two months old, and they have been exposed in light-tight cardboard boxes to such sunshine as has reached us during that period. They are quite unchanged.

It is, of course, possible that the stream of rays needs to be above a certain critical density in order to decompose the iodoform, but in any case my experiments prove that the β and γ rays reach us at most only in faint quantities from the sun. W. B. HARDY.

Gonville and Caius College, Cambridge.

Loss of Weight of Musk by Volatilisation.

I SHOULD like to direct the attention of your correspondent "S. W." (p. 496) to *N. Cimento* for May, 1902 (or abstract 1986, *Science Abstracts*, 1902), in which E. Salvioni says that he has shown the loss of weight of musk by volatilisation.

The measurements were made by a special form of balance. F. R. SEXTON.

Park Lodge, Kingston-on-Thames, September 5.

CONDENSATION NUCLEI.[1]

IN a previous paper under the not very appropriate title "Experiments with Ionised Air," Prof. Barus has described observations, made by means of his modified steam-jet methods, upon the nuclei found in air which has passed over phosphorus, together with measurements of the electrical leakage through air thus treated. The first chapter of the present volume is taken up with a continuation of the work by the methods there described.

There is no reason to expect the properties of air which has been exposed to phosphorus to be characteristic of ionised air generally; the recent experiments of Harms, and of Elster and Geitel, have, it is true, shown that ions are probably present, but the conditions are much more complicated than in cases of simple ionisation, such as that due to X-rays, owing to the presence of the products of the oxidation of the phosphorus. It is probably to the presence of the products of the oxidation of phosphorus vapour, as was pointed out in 1866 by Schmid, that the formation of the phosphorus cloud is due. The cloud nuclei are not free ions; in the "experiments with ionised air" it was found that the number of nuclei was undiminished by even a strong electric field; additional evidence is brought forward in the first chapter of the present paper, where experiments are described showing different temperatures for the maxima of nucleation and of ionisation. But such evidence was not required to show that these nuclei are not ordinary free ions, for in dust-free air ionised by X-rays or the rays from radio-active substances (in all cases, indeed, in which the ions have the normal velocity under

[1] "The Structure of the Nucleus, a continuation of 'Experiments with Ionised Air.'" By Carl Barus. (Smithsonian Contributions to Knowledge, Hodgkins Fund, 1903.)

a potential gradient of a volt per cm.) the same definite degree of supersaturation, approximately fourfold, is required to produce a cloud; the phosphorus cloud, on the other hand, does not require any sensible degree of supersaturation for its production.

There is evidence in these papers of strange misconceptions on the subject of ionisation. One is surprised in a paper dealing with "ionised air" to find such a statement as that on p. 53, "$n_0 = 3.6 \times 10^4$, agreeing very well with J. J. Thomson's 4×10^4 as the number of ions in air ionised to saturation by the X-rays."

In measurements of the leakage of electricity through air which has passed over phosphorus one would expect the apparatus to be designed in such a way that there should be no danger of the leakage observed being mainly due to the surface of the insulating supports becoming conducting by contact with the phosphorus fumes. The failure to take such precautions detracts greatly from the value of the electrical observation described in these papers.

Chapter ii. and the remaining chapters of the volume on the structure of the nucleus contain an account of experiments upon the clouds produced by rapid expansion. There can be no doubt that such experiments are easier of interpretation than those made by steam-jet methods. Prof. Barus begins with experiments on the colour phenomena attending the rapid expansion of moist air containing nuclei, generally phosphorus and "punk" nuclei. It is only when few nuclei are present, and the drops formed on expansion thus comparatively large, that *normal* coronas, as Barus calls them, are seen surrounding a luminous source viewed through the cloud. It is only to such coronas that the ordinary theory of the corona applies; the gorgeous colour phenomena observed when the drops are very small, numerous and uniform in size are much more difficult to interpret. If it were possible to deduce the size of the cloud particles from the colour phenomena observed with a given expansion, a most convenient method of determining the number of nuclei present would be available, for the quantity of water separating out as a consequence of a given expansion can be calculated, and hence the number of drops could be determined if the size of each were known. With this end in view Prof. Barus, in the absence of an exact theory of the colours, attempted to determine the size of the drops corresponding to a given arrangement of colours by an experimental method. On certain assumptions the relative numbers of the drops in a whole series of successive expansions, giving a corresponding series of colour phenomena, were known, the drops in the final expansions being large enough to give normal coronas, from which by comparison with lycopodium coronas the radii of the drops, and hence their number, could be determined; thence could be deduced the number and size of the drops in each of the previous expansions. It is very doubtful if the method can be made a trustworthy one.

Expansion experiments made with other vapours than that of water are next described, benzol, carbon bisulphide, ethyl and methyl alcohol and other vapours being used. Water vapour obviously differs from most other vapours in one very important respect, *i.e.* it is lighter than air. In the experiments made by Prof. Barus the air was contained in a large vessel with a pool of liquid at the bottom; when the liquid was water the moist air would rise to the top, and mixing would thus take place automatically by convection until the whole volume was saturated; in the case of liquids like benzol the heavy vapour-charged air would lie at the bottom, the vapour only gradually diffusing upwards. Uniform distribution of vapour, and hence the production of circular coronas on expansion, are to be expected with water, while with benzol, unless artificial stirring has been employed or a long interval has been allowed for diffusion, only the lowest strata will be saturated with vapour, and the amount of liquid available for each drop formed on expansion will, if the nuclei are uniformly distributed, diminish from below upwards; distorted coronas, or in extreme cases an arrangement of the colours in horizontal strata, are to be expected. The upper part of the vessel may remain free from cloud, the upper boundary of the cloud marking the level at which just enough vapour is present to give drops with the degree of expansion used. Even when uniform distribution of the vapour has been obtained, it will be destroyed by the first expansion made and the subsequent entrance of the dry air introduced to bring the pressure back to that of the atmosphere.

The phenomena observed by Prof. Barus are exactly what one would expect from these considerations, but he makes no reference to the above mentioned important difference in the conditions attending experiments with water vapour and with other vapours. His interpretation of the observed phenomena is, in fact, quite different. "When sulphur or other nuclei are put into the globe containing benzol vapour the result is peculiar. Instead of distributing themselves homogeneously throughout the receiver they usually collect in a heavy band near the bottom. This is invisible until revealed by the first exhaustion, when a heavy sluggish fog bank is seen, only a few centimetres high." Again, "The most curious feature in connection with benzol as well as the preceding liquids is the subsidence of the invisible nucleated air immediately after influx and without exhaustion." The "graded condensation" is interpreted as showing the nature of the distribution in the vessel, not of the vapour, but of the nuclei, and an elaborate series of experiments to determine the rates at which the nuclei travel in different vapours is described; that rate of diffusion of the vapour rather than of the nuclei is involved is by far the more natural interpretation. (In a short paragraph, inserted apparently subsequently to the writing of the paper, the possibility of this interpretation is admitted.)

The fifth chapter treats of the nuclei produced by shaking liquids, particularly aqueous solutions. The production of nuclei by shaking, bubbling and spraying has been noticed by several observers, and the effect of dissolved substances in the water upon the persistence of the nuclei has been studied by Mr. H. A. Wilson. Prof. Barus here gives an interesting series of observations on a large number of solutions of varying degrees of concentration. These nuclei are regarded as minute drops of the solution employed, which have evaporated until the concentration of the dissolved substance becomes great enough to counterbalance the effect of the curvature upon the vapour pressure. The conditions of equilibrium of small drops containing substances in solution are made clear by a diagram. There can be little doubt that the nuclei obtained by shaking solutions, and probably also those produced from phosphorus and from most of the other sources used by Prof. Barus, are of this nature. There is, indeed, nothing novel in the view that nuclei of this kind exist. Barus, however, seems to imply that all nuclei, including what other experimenters have taken to be the ions produced by X-rays and similar agents, are of this type.

An extraordinary interpretation is given (on p. 161) of the experiments by which it was sought to determine the difference in the action as condensation nuclei of the positive and negative ions. "If one introduces nuclei or makes nuclei by aid of the X-rays, in what is virtually the acid and alkaline side of a battery, even if the ionised moist air is the electrolyte,

one is conveying nuclei into or making nuclei out of different media." How it comes about that a perfectly definite degree of supersaturation is required to cause condensation on such nuclei, whether an electric field is applied or not, and whether they have been produced by strong or weak radiation or by other means, he does not attempt to explain. He brings forward in support of his view the further consideration that, "if a marked difference in efficiency of positive and negative ions is granted, then any ionised emanation neutral as a whole, like that of phosphorus, should produce two groups of nuclei. On condensation there should be two groups of coronal particles interpenetrating and subsiding through each other in the way I have frequently instanced in other experiments. No such effect has been observed." The answer to this is simply that the nuclei causing the phosphorus clouds are not free ions, like those produced by X-rays.

Prof. Barus concludes with a suggestion as to the origin of atmospheric electricity, according to which nuclei become negatively charged as the solution which they contain becomes diluted by absorption of water.

C. T. R. WILSON.

THE GEOLOGY OF AUSTRIA-HUNGARY.

TO know, even in a general fashion, the provinces of Austria-Hungary, with their immense range of scenic types and their picturesque variety of nationalities, goes far in itself towards a liberal education. The lover of landscape, as well as the geologist, will find much of interest in the new "Führer für die geologischen Exkursionen in Oesterreich," issued in connection with the ninth International Geological Congress in Vienna. This bulky work is divided, like that of the Russian congress, into numerous separate *brochures*, but forms, none the less, a permanent work of reference for our libraries. To obtain the guide and other publications before they become scarce, a subscription to the secretariat of the congress of twenty-seven shillings or so every three years seems not a heavy price to pay.

In the Austrian guide we have the work of some forty-five authors, describing in a compact and lucid form the districts that they have made their own. In this respect, though covering a far wider field, it resembles that handbook of English geology, the "Geological Excursions," issued by our Geologists' Association. The names of the writers imply in themselves the spirit of a scientific congress. We do not see the groups and cliques seated in the parliamentary Chamber in Vienna, and threatening one another with the literal outpouring of ink; but we find instead a body devoted in common to the reception of the stranger, and anxious that in each province he shall find something memorable and distinctive.

Dr. Jahn opens with the Older Palæozoic area of Bohemia, which includes the Moldau sections above Prag and the ravine at Karlstein, one of the noblest scenes of mediæval Europe. Prof. A. Hofmann describes the silver-mines of Pribram, and Prof. Slavík and others deal with the Cretaceous of northern Bohemia. In this latter paper it is pleasant to note the insertion of the euphonious Tchech names of villages after the German forms, a practice already to some extent imitated in Ireland. August Rosiwal conducts us through the more severely German district of Karlsbad and other health-resorts upon the frontier. Prof. Suess's important theory of the distinction between nascent and "vadose" waters appearing at the earth's surface is duly referred to. If this series of papers leads to a better appreciation of the rural districts of Bohemia, the writers will have done good service. Few visitors have seen what lies upon the plateau and outside the towns—the hamlets with bulbous church-towers, set of necessity beside the lakes, which gather in the hollows of the granite; the broad undulations of a purely agricultural landscape, broken here and there by some magnificent group of castle-towers; the crumpled rim of the country on the south-west, where one plunges down through the forest to Bavaria; or the sheer phonolite necks of the north, rising like islands above a haze formed by the smoke of Cainozoic coal. Here, however, we reach the holiday-region of the Elbe, known to dwellers in Dresden, and pleasantly described and illustrated by J. E. Hibsch in a *brochure* of seventy pages.

Another important series of papers deals with Galicia, the Miocene salt-beds of Wieliczka being, of course, included. Less visited are the petroleum-beds of Borysław, now one of the active fields of enterprise, where the folding of the Miocene strata assigns a maximum age to the uplift of the Karpathians. Oberbergrat Johann Holobek connects the various deposits of hydrocarbons with the extreme fissuring of the sandstones along the region of overfolding. Nearer the great chain, Oligocene menilite-shales are brought up over the Miocene on the south-west limb of the synclinal, and the oil, though flowing in fissures, appears generally accumulated in the bend.

What novelty lies before those who visit Drohobycz, Zaleszczyki, Kasperowce, and Worochta, following Drs. Grzybowski and Szajnocha, can only be known to those who have had glimpses of remote Galicia. Not the least interesting feature of Austrian Poland is the view of the drift-covered Russian plateau across the frontier, and the ever-present sensation of that mysterious and arbitrary *cordon*, along which the white-capped cavalry ride night and day and keep the verge of Europe.

From a geological point of view, the country of the famous limestone *Klippen* is of the first importance. Similar tectonic problems arise wherever beds of varying powers of resistance become crushed together. In a neat section V. Uhlig shows the relation of the northern "Klippenzone" to the overfolds and thrusts on the flank of the Tatra range. The fertile basin of Liptó is included on the south of the granite mass, and one can picture again the streams leaping into it from the forest-slopes of the Karpathians, and the grey crags towering up beyond, and the descent northward on the rain-swept levels of the Magura. This last region of little disturbed Eocene and Oligocene strata leads on to the highly faulted and upturned "Klippenzone." North of this the Older Cainozoic is strongly folded, whence Herr Uhlig concludes that the massive Klippen protected the corresponding beds on their south flank from the pre-Miocene earth-pressures. These same pressures had, however, considerable effect among the Klippen themselves, and have so far squeezed the masses of various ages together as to tend to obliterate unconformities. The author, however, urges that the band of Klippen represents a series of true islands of Jurassic strata in an Upper Cretaceous and Eocene sea, the deposits of which at one time practically overwhelmed them. They are thus not detached fault-blocks without roots, although the pre-Miocene movements have influenced their present prominence and position. Fig. 14 shows the bold character of the resulting scenery. The memoir then describes the structure of the Tatra chain, with a series of sections which will be welcomed by all who aspire to look further than the classic example of the Alps.

Perhaps one regretfully swings back to Salzburg and the Salzkammergut, though the detailed paper by E. Kittl on the stratigraphy of the latter area is accompanied by an admirable bibliography and a map